Cranberry Bioactive Substances Composition Change due to Resources-saving Processing

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Abstract

Cranberry was processed with resources-saving technology. Physicochemical composition of initial berries and their processing products has been explored at different phases of moisture evaporation and after long-term storage. It is shown that having high biological value, dry juice and dry pulp refuse considerably overbalance of initial berry by the content of bioactive substances set. Vitamin and mineral compositions of cranberry processing products have been ascertained and their essential content excess has been shown relatively to the berry. The regularities of bioactive substances content change have been determined for the resources-saving processing of cranberry and for the long-term storage of processing products.

Keywords

Cranberry; Resources-Saving Processing; Bioactive Processing Products

Introduction

Carried out at low temperature, the resources-saving processing minimizes losses in the biological value of plant raw material and allows receiving foodstuffs with high content of bioactive substances (Emelyanov, Alexander A, 2010). One of valuable foodstuffs we explored is cranberry. Berries contain organic acids, sugars, pectin, coloring substances, ascorbic acid, and mineral substances (Khimicheskii sostav produkta klyukva). Cranberry, used as a natural preserving agent and antioxidant, and with bactericidal and antimicrobial actions, is capable of eliminating slag and heavy metals salts from the body, and reduces negative consequences of radioactive irradiation. The resources-saving processing of cranberry allows receiving new ingredients with high content of the bioactive substances. The physicochemical composition changes due to the processing.

To show the regularities in bioactive substance content change at different stages of the resources-saving processing, the biological value of cranberry along with its ingredients was explored.

Experimental

We pressed the juice from earlier prepared berries. Moisture content compounded 88 % for berries, 72 % for the direct extraction juice, and 80 % for the pulp refuse.

The juice was concentrated in vacuum at the temperature below 50 °C with the set (Emelyanov, Alexander A, 2008). The moisture of concentrated juice was 57 %. The concentrated juice and the pulp refuse were dried in the convective dryer at the temperature below 50 °C. When the concentrate and the refuse achieved the sufficient level of moisture during the drying, they were passed through the extruder with production of grains. Moisture of the granular juice was 46 %. The grains at the temperature below 50 °C were dried and dispensed. Before dispensing, moisture of the granular juice was 34 %. The powdery juice and the pulp refuse were dried in convective dryer. Moisture of the powdery juice was 25 %; and moisture of the powdery refuse was 22 %.

During the processing, we took samples to check the food and biological value. Simultaneously with the juice samples, we checked the berry and the juice powders as well as the pulp refuse of cranberry which were received with the same technology and have been saved for 2 years in the ordinary terms at room temperature. After the long-term storage, the moisture of the juice powder was 22 %; and the moisture of the refuse powder was 13 %.

Fig. 1 shows the granular and powdery juices as well as the powder of pulp refuse of cranberry.

(A) (B) (C)

FIG. 1 GRANULAR (A) AND POWDERY (B) JUICES AND PULP REFUSE POWDER (C) OF CRANBERRY

TABLE 1 BIOLOGICAL VALUE OF BERRY AND PROCESSING PRODUCTS OF CRANBERRY

No	Factor	Berry	Juice						Refuse		
			Direct Extraction	Concentrate	Grains		Powder		Direct Extraction	Powder	
1	Water, %	88	72	57	46	34	25	22	80	22	13
2	Protein, %	0.39	0.7	2.3	2.8	5.4	3.3	3.0	3.6	4.2	2.9
3	Reducing sugar, %	0.62	0.26	0.18	0.18	0.88	0.88	0.26	0.44	0.18	0.18
4	Pentose's, %,	2.69	0.19	1.19	1.25	2.62	1.43	1.49	1.86	3.15	2.78
5	including: water-insoluble	2.59	0.13	1.01	1.11	2.48	1.34	1.43	1.75	3.0	2.76
6	water-soluble	0.1	0.06	0.18	0.14	0.14	0.09	0.06	0.11	0.15	0.02
7	Cellulose, %	1.23	0.38	0.76	1.46	1.9	2.25	1.88	3.12	2.3	2.6
8	Pectin, %	0.58	0.67	0.73	0.89	0.5	0.8	0.5	0.66	0.86	1.08
9	Organic acids, %	3.4	16.8	36.9	63.7	57.1	62.9	63.7	50.3	23.5	36.9
10	Catalase, mg H_2O_2/g	0.034	0.068	0.088	0.17	0.085	0.044	0.034	0.051	0.023	0.102

TABLE 2 VITAMINS CONTENT OF BERRY AND PROCESSING PRODUCTS OF CRANBERRY

No	Factor, mg/100 g	Berry	Juice						Refuse		
			Direct Extraction	Concentrate	Grains		Powder		Direct Extraction	Powder	
1	Water, %	88	72	57	46	34	25	22	80	22	13
2	β-carotene	0.03	0.09	0.08	0.17	0.86	0.98	1.9	0.2	2.05	1.57
3	Riboflavin, B_2	0.02	0.03	0.12	0.16	0.42	0.65	0.77	0.2	0.88	0.78
4	Pyridoxine, B_6	0.02	0.02	0.08	0.12	0.3	0.39	0.42	0.19	0.62	0.44
5	Niacin, PP	0.15	0.22	0.33	0.54	1.33	1.62	2.17	0.9	2.85	2.44
6	Ascorbic acid, C	21.0	41.8	62.2	68.8	34.6	40.8	37.5	5.1	12.5	15.0

Physicochemical Properties

To examine the physicochemical properties of cranberry and its processing products, standard methods were employed. The data for the mineral composition were received with the instrumentality of the X-ray analyzer of Jeol electron microscope.

TABLE 1 shows data of the biological value of cranberry and its processing products at different stages of moisture removal and after the long-term storage.

As shown in TABLE 1, the processing products of cranberry possess the biological value and essentially outbalance the initial berry by the range of components. The excess multiplicity of the individual biologically significant components is constitutive and compounds for the concentrated juice up to 19 for organic acids, up to 12 for protein, up to 5 for catalase. The refuse powder exceeds the berry by a subset. The excess reaches an order of magnitude for proteins and organic acids and twofold for cellulose, pectin, and water-soluble pentose's. The refuse powder is equal to

TABLE 3 MACRO- AND MICROELEMENTS CONTENT OF BERRY AND PROCESSING PRODUCTS OF CRANBERRY

No	Factor, mg/100 g	Berry	Juice						Refuse		
			Direct Extraction	Concentrate	Grains		Powder		Direct Extraction	Powder	
1	Water, %	88	72	57	46	34	25	22	80	22	13
2	Potassium, K	324	265	388	479	586	647	583	217	194	167
3	Sodium, Na	28.4	21.6	24.4	28.6	37.6	48.9	44.2	9.2	11.3	12.6
4	Calcium, Ca	23.2	11.7	13.9	14.4	20.2	25.2	28.1	18.4	56.1	48.8
5	Magnesium, Mg	14.1	4.34	6.8	9.4	15.5	19.7	16.4	13.5	48.8	39.1
6	Phosphorus, P	21.6	6.2	7.9	9.3	12.5	14.6	16.8	18.6	29.4	42.7
7	Sulfur, S	1.8	0.38	0.45	0.67	0.81	1.1	1.7	1.2	2.9	3.8
8	Chlorine, Cl	10.1	7.8	9.2	13.7	17.4	28.6	20.1	3.9	5.5	6.2
9	Iron, Fe,	1.13	0.76	0.98	1.28	2.14	2.33	2.68	0.69	3.19	4.24
10	Copper, Cu	0.168	0.147	0.156	0.229	0.302	0.369	0.267	0.128	0.285	0.318
11	Manganese, Mn	0.232	0.103	0.158	0.187	0.204	0.238	0.215	0.184	0.227	0.369
12	Molybdenum, Mo	0.036	0.01	0.018	0.032	0.048	0.063	0.044	0.024	0.056	0.088
13	Zinc, Zn	0.125	0.107	0.126	0.144	0.185	0.205	0.189	0.178	0.183	0.216

the berry by the content of the water-insoluble pentoses. The refuse outbalances three times than the berry by the content of the reduce sugars. The refuse outbalances the juice and the berry by the content of cellulose and pectin.

The vitamin content of the berry and the processing products of cranberry are presented in TABLE 2.

It can be seen from TABLE 2 that the berry and the processing products of cranberry are rich in vitamins. The processing products appreciably outbalance the berry in β-carotene and B-group vitamins content. For the concentrated juice, the excess multiplicity is up to 63 for β-carotene, up to 39 for riboflavin, up to 21 for pyridoxine, up to 15 for niacin, and up to 3.3 for ascorbic acid. For the refuse powder the excess multiplicity is up to 68 for β-carotene, up to 44 for riboflavin, up to 31 for pyridoxine, and up to 19 for niacin. The ascorbic acid content of the refuse is lesser than the content of the berry. High content of β-carotene and B-group vitamins provides biological activity for the processing products of cranberry.

TABLE 3 shows macro- and microelements content of berry and processing products of cranberry for different phases of the moisture removing.

As shown in TABLE 3, the concentrated juice and the dry pulp refuse of cranberry reach in mineral substances. The juice and the refuse outbalance the berry on the content of the components range. For the concentrated juice, the excess multiplicity is up to 2.8 for chlorine, up to 2.4 for iron, up to 2.2 for copper, up to 2 for potassium, and up to 1.7 for sodium and molybdenum. For the refuse powder, the excess multiplicity is up to 3.8 for iron, up to 3.5 for magnesium, up to 2.4 for calcium and molybdenum, and up to 2 for potassium, phosphorus, and copper. High content of iron, molybdenum, copper, and manganese provides the biological activity for the processing products of cranberry.

Bioactive Substances Content Change

We plotted the curves of relative change of the bioactive elements content in the process of cranberry juice concentration as functions of the solid content. The curves have been plotted as a result of physicochemical composition examination. The relative change is represented by the multiplicity of the content change of juice bioactive value elements with respect to the berry.

Fig. 2 shows the change in the curves standing for the content multiplicity of organic acids (curve *1*), proteins (*2*), cellulose and pectin (*3*) in the process of cranberry juice concentration as a function of the solid content.

It can be seen from curve *1* that the concentration of the organic acid was uninterruptedly increasing till attaining the saturation. The maximal concentration of the organic acid was 64 % and outbalanced the concentration in cranberry in 19 times.

The proteins content of the juice has grown more than on an order of magnitude from 0.39 % to 5.4 % as a result of the vacuum evaporation. Though, following

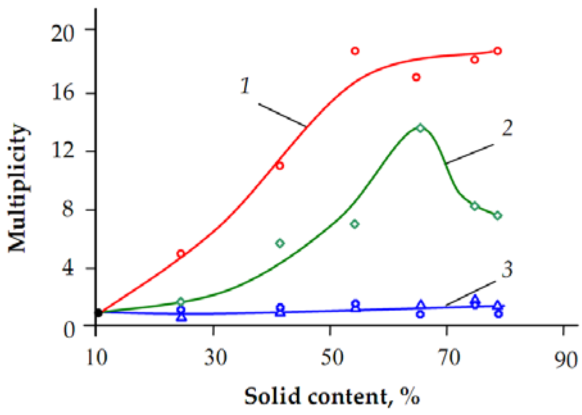

FIG. 2 MULTIPLICITY CHANGE IN THE CONTENT OF ORGANIC ACIDS (1), PROTEINS (2), AND CELLULOSE AND PECTIN (3) OF CRANBERRY JUICE RESPECTING TO BERRY AS A FUNCTION OF SOLID CONTENT

the grinded grains, the convective drying and the long-term storage of the powdery juice have resulted in the decrease of 3 % in the concentration.

The cellulose and pectin content was constant during the processing and storage and corresponded to the content in cranberry.

Fig. 3 shows the dependences of the relative change in the pentose's content as functions of the solid content during cranberry processing.

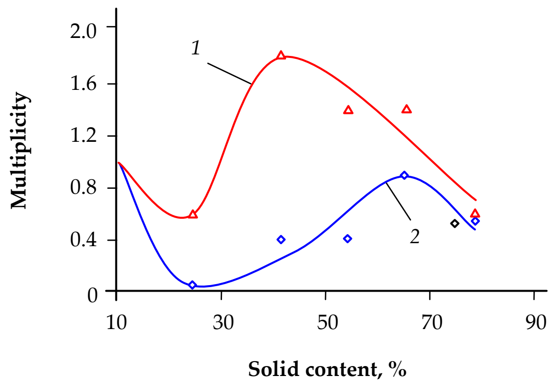

FIG. 3 MULTIPLICITY CHANGE IN THE CONTENT OF JUICE PENTOSE'S RESPECTING TO BERRY AS A FUNCTION OF SOLID CONTENT: *1* – WATER-SOLUBLE; *2* – WATER-INSOLUBLE

As the presented curves shown, the berries extraction has resulted in decrease in the pentose's concentration of juice comparing to cranberry by 40 % for water-soluble pentose's (*1*) and in 20 times for pentose's insoluble in water (*2*).

The vacuum evaporation of juice has raised the content of water-soluble pentoses for 80 % to the maximal value of 0.18 %. Their concentration was steadily falling down to the value less than in berry in the process of convective drying, the juice graining, the grains grinding, and the long-term storage of the powdery juice.

For water-insoluble pentose's, their concentration was steadily increasing remaining less than the concentration in cranberry during the vacuum evaporation, the convective drying, and the juice graining. The grains grinding, the powder drying, and the long-term storage of the powdery juice reduced the pentose's content.

We explored the catalase activity of cranberry and its processing products. The biological role of catalase consists in protection of cellular conformations from breakdown by the action of hydrogen peroxide. The catalase activity was estimated by the amount of H_2O_2 (mg) decomposed at the incubation time of 1 g of the raw material.

Fig. 4 shows the dependences of the relative change in the concentration of catalase (*1*) and reducing sugars (*2*) of cranberry juice as functions of the solid content.

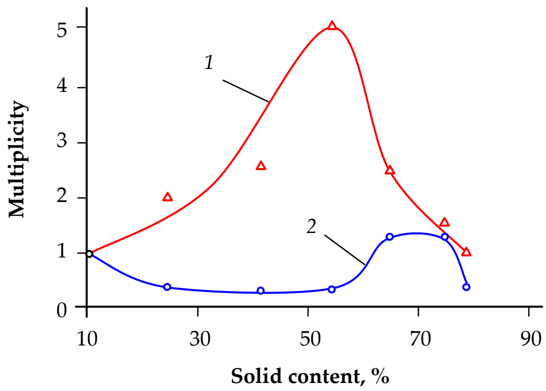

FIG. 4 MULTIPLICITY CHANGE IN THE CONTENT OF CATALASE (*1*) AND REDUCE SUGARS (*2*) OF JUICE RESPECTING TO BERRY AS A FUNCTION OF SOLID

It follows from the presented curves that the catalase activity quintuple increases during the juice extraction, the vacuum evaporation of the direct extraction juice, the convective drying of concentrate, and the juice graining accompanying by the growth of the solid content from 12 % to 56 %. The catalase activity decreases down to the value of the raw product consequently in the process of the grinding, the drying, and the long-term storage.

The content of the reducing sugars had decreased doubly at the extraction and was constant at the vacuum evaporation, the drying, and the graining. The convective drying of the grained juice has elevated the content of the reduce sugars by 40 %. The grain grinding, the powder drying, and the long-term

storage of the powdery juice have reduced the content of the reducing sugars more than two times.

Fig. 5 shows the dependences of the multiplicity change in the content of vitamins in cranberry juice as functions of the solid content.

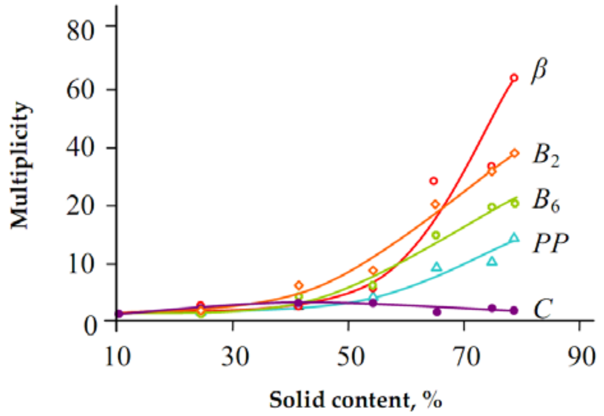

FIG. 5 MULTIPLICITY CHANGE IN THE CONTENT OF CAROTENE (β), RIBOFLAVIN (B_2), PYRIDOXINE (B_6), NIACIN (PP), AND ASCORBIC ACID (C) OF JUICE RESPECTING TO BERRY AS A FUNCTION OF SOLID CONTENT

As it follows from the presented curves, the content of β-carotene and B-group vitamins steadily increases during the processing. The juice extraction from berries and the vacuum evaporation of the direct extraction juice have provided triple increasing of the ascorbic acid content up to 62 mg/100 g in the concentrated juice. Though, the content of the ascorbic acid has decreased consequently the convective drying, the grinding, and biannual storage of the powdery juice down to the value of 37.5 mg/100 g that 2-times exceeds the berry content.

Fig. 6 shows the dependences of the content change multiplicity of macro- and microelements in cranberry juice as functions of the solid content.

It follows from the presented curves that respecting to

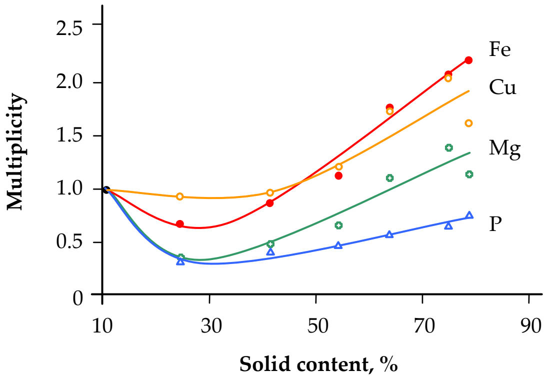

FIG. 6 MULTIPLICITY CHANGE IN THE CONTENT OF IRON (Fe), COOPER (Cu), MAGNESIUM (Mg), AND PHOSPHORUS (P) OF JUICE RESPECTING TO BERRY AS A FUNCTION OF SOLID CONTENT

the berry, the concentration of the mineral substances in juice decreased after the juice extraction. Though, the concentration of the macro- and microelements was uninterruptedly increasing with the solid content accretion in the process of moisture removal. The multiplicity of the concentration excess was up to 2.4 for iron, up to 2.2 for copper, and up to 1.4 for magnesium respecting to the berry.

Conclusions

Thus, we explored change in physicochemical composition of cranberry processing products. It is shown that the processing products possess high biological value and overbalance berry up to 19 times by the content of organic acids, up to 12 times by the content of proteins, up to 5 times by catalase activity, and up to 2 by the content of pentose's. The vitamin composition of the processing products of cranberry is explored. It is shown that the processing products outbalance berry by β-carotene content was up to 68 times, by riboflavin content up to 44 times, by pyridoxine content up to 31 times, and by ascorbic acid content up to 3 times. The mineral composition is determined and it is shown that the processing products outbalance berry by iron content up to 3.8 times, by magnesium content up to 3.5 times, by the content of calcium, sulfur, phosphorus, copper, molybdenum, and zinc up to 2.0-2.4 times.

We have determined the regularities of the content change of the bioactive substance during the resources-saving processing of cranberry and the long-term storage of the received ingredients.

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